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Applicants: K. SHIBATA, et al

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Sir:

Attached is a Sworn English Translation of the priority documents submitted on even date herein for the above-referenced application. The attached is being submitted in order to perfect Applicants claim of priority.

To the extent necessary, applicants petition for an extension of time under 37 C.F.R. section 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 01-2135 (Case No. 500.39409X00) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

Carl I. Brundidge
Registration No. 29,621
ANTONELLI, TERRY, STOUT & KRAUS, LLP

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DECLARATION

I, Yasuhito Kajikawa, a member of Intertec Corporation of Toranomon Akiyama bldg., 22-13, Toranomon 1-chome, Minato-ku, Tokyo, Japan do solemnly and sincerely declare that I well understand the Japanese language and English language and the attached English version is full, true and faithful translation of the Japanese Patent Application No. 2000-46997.

And I made this solemn declaration conscientiously believing the same to be true.

This 6th day of October, 2004

Yasuhito Kajikawa

Yasuhito KAJIKAWA

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(71) Applicant: 000005108

Hitachi, Ltd.

6, Kanda Surugadai 4-chome, Chiyoda-Ku, Tokyo

(72) Inventors: Koichi SHIBATA, Masaru IGAWA, Koichi MORITA, Shuichi SAKAMOTO

c/o Enterprise Server Division, Hitachi, Ltd., 1, Horiyamashita, Hadano-shi, Kanagawa

(74) Agent: Patent Attorney, Masatoshi ISOMURA (and other one person)

[Title of the Invention]

VIDEO SERVER FOR VIDEO DISTRIBUTION SYSTEM

[Abstract]

[Object] To provide a video server which can transmit a same video content to a plurality of terminals by using a multicast technology even where a firewall is interposed between the video server and the terminals, so that the transmission cost can be reduced.

[Means for Attaining the Object] A same video content (multicast image information) is transmitted in parallel to a plurality of receiving audience terminals 103B, such that when

the multicast image information passes through a transmission path (HTTP network) 11 including a firewall 104 and/or others which does not support a multicast function, a protocol in accordance with which the multicast image information is transmitted is once switched to the HTTP protocol from a multicast protocol; then, when the multicast image information enters into a transmission path (IP network 12B) which allows multicast to pass therethrough, the protocol in accordance with which the multicast image information is transmitted is again switched to the multicast protocol. Since the transmission rate of an IP network which does not allow multicast to pass therethrough is limited, speed adjusting buffers are used to convert the transmission rate, when the switching between the protocols is performed.

[Claims]

[Claim 1] A video server for a video distribution system wherein a digitized video content is transmitted in parallel to a plurality of terminals by using the Internet protocol, such that before the digitized video content passes through a transmission path not supporting multicast using the Internet protocol (hereinafter referred to as the IP multicast), a protocol in accordance with which the digitized video content is transmitted is switched to the HTTP (Hyper-Text Transfer Protocol) protocol from an IP multicast protocol, and when the digitized video content has passed through the transmission path, the protocol in accordance with which the digitized video

content is transmitted is switched to the IP multicast protocol again, the video server being characterized by comprising:

means for determining whether or not a video content requested from one of the terminals is stored in the video server;

means for transmitting a transmission request to another video server for transmitting the video content thereto in accordance with the HTTP protocol when it is determined that the video content requested by the terminal is not stored in the video server; and

means for receiving the video content transmitted from the other video server in accordance with the HTTP protocol and transmitting the video content in parallel to the plurality of terminals using the IP multicast protocol or the HTTP protocol.

[Claim 2] A video server for a video distribution system wherein a digitized video content is transmitted in parallel to a plurality of terminals by using the Internet protocol, such that before the digitized video content passes through a transmission path not supporting multicast using the IP multicast, a protocol in accordance with which the digitized video content is transmitted is switched to the HTTP protocol from an IP multicast protocol, and when the digitized video content has passed through the transmission path, the protocol in accordance with which the digitized video content is transmitted is switched to the IP multicast protocol again, the video server being characterized by comprising:

a plurality of memory devices for detecting a random

access point in image information of the transmitted video content, from which reproduction of the image information can be started without a trouble, and storing the image information up to the next random access point;

means for selecting, from among image information stored in the plurality of memory devices, image information which has not been transmitted and is the most recent, at the time when a request for a transmission of the image information is received in accordance with the HTTP protocol by an origination of the video content; and

means for transmitting the selected image information to a destination in accordance with the HTTP protocol or the IP protocol.

[Claim 3] A video server for a video distribution system wherein a digitized video content is transmitted in parallel to a plurality of terminals by using the Internet protocol, such that before the digitized video content passes through a transmission path not supporting multicast using the IP multicast, a protocol in accordance with which the digitized video content is transmitted is switched to the HTTP protocol from an IP multicast protocol, and when the digitized video content has passed through the transmission path, the protocol in accordance with which the digitized video content is transmitted is switched to the IP multicast protocol again, the video server being characterized by comprising:

caching means provided in a portion of the video server for receiving a video content from another video server in

accordance with the HTTP protocol and switching the protocol in accordance with which the video content is transmitted, to the IP multicast protocol, the caching means caching the received video content; and

means for transmitting the video content cached in the cashing means, when an audience request for the same video content is again transmitted from one of the terminals.

[Claim 4] A video server for a video distribution system wherein a digitized video content is transmitted in parallel to a plurality of terminals by using the Internet protocol, such that before the digitized video content passes through a transmission path not supporting multicast using the IP multicast, a protocol in accordance with which the digitized video content is transmitted is switched to the HTTP protocol from an IP multicast protocol, and when the digitized video content has passed through the transmission path, the protocol in accordance with which the digitized video content is transmitted is switched to the IP multicast protocol again, the video server being characterized in that:

the video server holds fragments of a video content requested from one of the terminals in the form of packets, and

the terminals respectively and sequentially requests, using the HTTP protocol, the video server to transmit the fragments, such that each time a request is received from one of the terminals, the video server transmits to the terminal the most recent one among the fragments in the form of the packets which have not been transmitted yet to the terminal.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a video server for transmitting a video signal in parallel to a plurality of locations using the Internet protocol, and more particularly, to a video server for a video distribution system which enables transmission of a video signal through a transmission path, which cannot use IP multicast, through protocol conversion.

[0002]

[Prior Art] Simultaneous transmission of a signal such as a video signal to multiple locations, utilizing a protocol such as the Internet protocol, is referred to as "multicast," and a number of methods for realizing the multicast have already been proposed, with some of such methods already brought into practical use. A representative one of these methods is the Internet multicast technology which has been published as a standard designated "RFC1112" of Internet Engineering Task Force (IETF).

[0003] A critical component of the multicast technology is a host group model. Multicast information is transmitted to a host group indicated by some multicast address, such that each of terminals attempting to share the multicast information receives the information addressed to the host group. In a network based on the Internet protocol, multicast information is accompanied by a "multicast address," used as a destination

address, which indicates that the information is multicast.

[0004] Upon receiving multicast information, a device for controlling an information transmission path, i.e., a "router" reads its multicast address, and transmits the multicast information to a path to which a terminal belonging to an associated host group is connected. In this event, when a plurality of terminals belong to the associated host group and they are located on different paths, the router copies the information intended for transmission, and transmits the copies to the respective paths. This scheme allows for a large reduction in the amount of transmitted information, as compared with independent transmission of information from an origination to all terminals belonging to a host group.

[0005]

[Object to be Attained by the Invention] However, the effectiveness of the multicast-based transmission is limited only to those paths which support the multicast from an origination to all terminals belonging to a host group. Additionally, in the current Internet environment, firewalls are installed everywhere as required for the security, preventing the Internet protocol information from freely passing therethrough.

[0006] The firewall refers to a device for examining information which is going to pass therethrough to block information other than that regarded as safe. Multicast information is generally blocked by the firewall. Therefore, a special setting is required for multicast information to pass

through the firewall. However, it is quite difficult to pass multicast information through in the current Internet in which firewalls are installed everywhere and managed independently by different organizations.

[0007] Therefore, for transmitting the same video simultaneously to a plurality of terminals when firewalls are interposed between a video server and the terminals, the video is conventionally transmitted individually from the video server to each of the terminals. In this event, the amount of information transmitted from the video server to the terminals is increased in proportion to the number of receiving terminals, resulting in a problem of a higher transmission cost.

[0008] It is an object of the present invention to provide a video server for a video distribution system which is capable of solving the above-mentioned problems, and transmitting the same video from a video server to a plurality of terminals utilizing the multicast to reduce the transmission cost even when firewalls are interposed between the video server and the terminals.

[0009]

[Means for Attaining the Object] To attain the above-described object, the present invention provides a video server for a video distribution system which is adapted such that when information is distributed to a plurality of terminals over a firewall (see a firewall 104 in FIG. 1) by using a multicast technology, a protocol in accordance with which the information is transmitted is switched from a multicast

protocol to a protocol in accordance with which the information can pass through the firewall, and once the information has passed through the firewall, the employed protocol is switched to the multicast protocol again.

[0010] More specifically, the video server transmits a transmission request to another video server for transmitting a video content thereto in accordance with the HTTP protocol when the video content is requested by one of the plurality of terminals but is not stored in the video server, and receives the video content transmitted from the other video server in accordance with the HTTP protocol and transmits the video content in parallel and simultaneously to the plurality of terminals using the IP multicast protocol or the HTTP protocol.

[0011] Further, the video server is adapted to detect a random access point in image information of the transmitted video content, from which reproduction of the video content can be started without a trouble, and stores the image information up to another random access point in one of a plurality of memory devices (see speed adjusting buffers 406A-406C shown in Figs. 5 and 7), so that when a request for a transmission of image information is received in accordance with the HTTP protocol by the transmission side, there is selected, from among image information stored in the plurality of memory devices, image information which has not been transmitted yet and is the most recent, and the selected image information is transmitted the reception side in accordance with the HTTP protocol or the IP protocol.

[0012] In a portion of the video server for receiving a video content from another video server in accordance with the HTTP protocol, and switching the protocol in accordance with which the video content is transmitted, to the IP multicast protocol, there is provided caching means (see a video storage 404 in Figs. 5 and 7) for caching the received video content, so that the video content cached in the cashing means is transmitted when an audience request for the same video content is again transmitted from one of the terminals.

[0013] The video server holds fragments of a video content requested from one of the terminals in the form of packets, and the terminals respectively and sequentially requests, using the HTTP protocol, the video server to transmit the fragments, such that each time a request is received from one of the terminals, the video server transmits to the terminal the most recent one among the fragments in the form of packets which have not transmitted yet to the terminal. (See a transmitter for terminal A 704A and a receiver of terminal A 708A shown in FIG. 8.) The invention accomplishes the object by the above-described arrangements.

[0014]

[Embodiment of the Invention] (Summary) To attain the object, a video server according to the invention is adapted such that when information is distributed to a plurality of terminals over a firewall by using multicast, a protocol in accordance with which the information is transmitted is switched from a multicast protocol to a protocol according to which the

information can pass through the firewall, and when the information has passed through the firewall, the protocol in accordance with which the information is transmitted is switched to the multicast protocol again.

[0015] However, many of protocols for passing information through a firewall are inherently intended for file transfer, so that although they can transmit information without errors, they do not guarantee when the information will arrive at a particular terminal. Applications which require the multicast often involve real-time transmission such as transmission of video and audio contents. Therefore, a mechanism for matching the transmission rate between reception and transmission of video and audio contents is required for a relay point for switching the protocols.

[0016] Currently, the protocol in accordance with which information is allowed to pass through the largest number of existing firewalls is, the HTTP protocol. The HTTP protocol is a simple protocol for obtaining a file such as of hyper text through a network. According to the invention, multicast information is once transmitted in accordance with the HTTP protocol to a relay device which is capable of transmitting the information by multicast to receiving terminals, and at which the protocol employed is switched to the multicast protocol, and the information is then multicast therefrom to the terminals belonging to a host group.

[0017] This is because transmission by the HTTP protocol is for transferring a file of relatively small size in a close

to the random access, and the existing networking equipment is mostly optimized for such a mode of transmission. Therefore, in the invention also, when a video content is transmitted in accordance with the HTTP protocol, image information of the video content is divided into small fragments, which are sequentially transmitted each as a file. According to the arrangement, there can be obtained an effect that even if a transmission of the image information is delayed due to transmission failures or others, transmission of a part of the fragments of the image information is given up, but the transmission of the image information is resumed from the most recent fragment, thereby preventing a permanent accumulation of transmission delays.

[0018] Mostly, such an HTTP-based transmission can not sufficiently make use of a bandwidth of a transmission path, under typical conditions. This is because a transmission path is left unused from a first point of time when the reception side requests each fragment of the image information to a second point of time when the video server of the transmission side starts transmitting the fragment after receiving the request and establishing a connection with the reception side.

[0019] To solve this problem, this invention simultaneously establishes a plurality of logical connections between the transmission and reception sides, and the reception side sequentially transmits requests for transmissions of fragments of image information to the respective connections, receives the fragments of the image information for the

respective connections independently, and transmits the received fragments not in order of reception, but in order of time from the least recent one to the most recent one, to an image decoder. Thus, the utilization efficiency of the transmission path between the transmission side and the reception side is improved.

[0020] There will be described in detail one embodiment of the invention, referring to the drawings. FIG. 1 illustrates an example of a video distribution system in which two video servers according to the present invention are connected through a transmission path which does not allow IP multicast to pass therethrough. A video content stored in a video storage 102A of a video server 101A can be transmitted simultaneously to client terminals 103A through an IP network 12A using an IP multicast transmission scheme.

[0021] However, as to client terminals 103B connected to an IP network 12B, IP multicast-based transmission cannot be realized from the video server 101A to the client terminal 103B, though connected to the network 12B, because a network connecting the IP network 12A and the IP network 12B has a firewall 104 interposed therebetween and serves as a network dedicated to HTTP.

[0022] To eliminate this inconvenience, the present invention transmits image information of a video content using the HTTP protocol only when the image information is passed through an HTTP network. For example, when a client terminal 103B requests to view a video content stored in the video storage

102A and multicast to the client terminals 103A, the video server 101A transmits image information to the client terminals 103A using the IP multicast, and simultaneously transmits the image information to the video server 101B through the HTTP network 11 using the HTTP protocol.

[0023] The video server 101B receives the image information transmitted from the video server 101A, and multicasts the image information to the client terminals 103B using the IP multicast.

[0024] FIG. 2 is a diagram for explaining the operational flow of the video distribution system utilizing the video servers described in connection with FIG. 1. Here, explanation will be given of how a video content stored in a video storage 216 of a video server 211 is viewed on a client terminal 202.

[0025] A video server 201 comprises a video management unit 203 and a video delivery unit 205. Image information of each video content is stored in a video storage 206, while identification information, attributes and so on for identifying the name and file of particular video content are managed by a video management table 204 which is referenced by the video management unit 203.

[0026] Similarly, the video server 211 comprises a video management unit 213 and a video delivery unit 215. Image information of each video content is stored in a video storage 216, while identification information, attributes and so on for identifying the name and file of a particular image content are managed by a video management table 214 which is referenced by

the video management unit 213.

[0027] FIG. 3 is a flow chart for explaining the operation of the video distribution system illustrated in FIG. 2. In the following, the operational flow in the video distribution system illustrated in FIG. 2 will be explained along the flow chart of FIG. 3.

[0028] Assume that the client terminal 202 issues a video audience request 21 to the video management unit 203 in the video server 201 (step S1). In this event, the video management unit 203 references the video management table 204 to determine whether or not the requested video content is stored in the video storage 206 (step S2), and sends a transmission command 23 to the video delivery unit 205 (step S3) when determining that the video content is stored in the video storage 206 (step S2: Y). In this way, the video delivery unit 205 retrieves the requested video content 24 from the video storage 206 for delivery to the client terminal 202 (step S4). In this event, the video delivery unit 205 may also transmit the video content 24 simultaneously to a plurality of other terminals using the IP multicast as is the case with the client terminal 202.

[0029] On the other hand, when the requested video content is not stored in the video storage 206 (step S2: N), the video management unit 203 sends an audience request 25 to the video management unit 213 in the other video server 211 (step S5). The video management unit 213, upon receipt of the audience request 25, references the video management table 214 to determine whether or not the requested video content is stored

in the video storage 216. When stored, the video management unit 213 sends a transmission command 27 to the video delivery unit 215, and sends to the video management unit 203 in the video server 201 reception parameters 26 required for receiving the video content from the video delivery unit 215 (step S6).

[0030] When the requested video content is not stored in the video storage 216, the video server 201 sends an audience request to still another video server. The video server 201 repeats this operation, and returns an error or the like when the requested video content is not stored in any video server.

[0031] Turning back to the explanation of the operational flow, the video delivery unit 215, upon receipt of the transmission command 27, uses the HTTP protocol to retrieve image information of interest from the video storage 216 and transmit the retrieved image information to the video delivery unit 205 in the video server 201 in accordance with the transmission command 27 (step S7). Upon receipt of the reception parameters 26, the video management unit 203 sends the transmission command 23 adapted for the parameters 26 to the video delivery unit 205, and transmits to the client terminal 202 reception parameters 22 which are required to receive the video content (step S8).

[0032] The video delivery unit 205 receives an HTTP-based video content 28 from the video delivery unit 215 in the video server 211 in accordance with the received transmission command 23, and again transmits the video content 28 to the client terminal 202 as image information 24. In this event, the image

information received by the video delivery unit 205 is also stored in the video storage 206 for registering its title and so on in the video management table 204, as a cache which is temporary information (step S9).

[0033] Subsequently, when an audience request for the same video content is again transmitted from a client terminal, the video management unit 203, at this time, can find the requested video content registered in the video management table 204 as a cache, sends a transmission command 23 to the video delivery unit 205, retrieves the image information 24 stored in the video storage 206, and transmits the image information 24 to the client terminal 202 (steps S3, S4). In this event, since the image information need not be retrieved and transmitted from the video storage 216 in the video server 211, the transmission cost can be considerably reduced.

[0034] FIG. 4 is a diagram illustrating an example of management information stored in the video management tables 204, 214. In FIG. 4, assume that a server 1 is a video server which holds the video management table, and servers 2, 3, …are other video servers. The video management table describes perfect information on video contents stored in the server 1. For video contents stored in the other servers 2, 3, …, information on video contents once transmitted in the past is described in a cache directory. An audience request for a video content which is not described in the cache directory is queried sequentially to the other servers as mentioned above. Each video content is managed by a video title (for example, "movie 1"),

attribute information thereof (the type of the video content, initialization parameters for decoding the video content, dimensions of the vertical side 720 and the horizontal side 480, and so on), the location of the file (for example, a file name such as "video A.movie"), and so on.

[0035] The example of FIG. 4 shows that video contents 3, 4 are recorded in a directory 1 of the server 1; video contents 5, 6 in a directory 2; a directory 4 and a video content 7 in a directory 3; video contents 8, 9, 10 in the directory 4; and video contents 1, 2 directly in the server 1. Also, FIG. 4 shows that in the cache directory video contents 11, 12, 13, 14 have been once transmitted from the servers 2, 3, 4, respectively, and stored in the server 1 as caches.

[0036] FIG. 5 is a block diagram illustrating an exemplary configuration of the video delivery unit. The video delivery unit illustrated in FIG. 5 corresponds to the video delivery unit 205 in the video server 201 previously described with reference to FIG. 2, and shows a specific configuration for delivering HTTP-based image information transmitted from the other video server 211 to the client terminal 202.

[0037] As illustrated, the video delivery unit comprises an HTTP reception buffer 401; an HTTP receiver 402; a file writer 403; a video storage 404; a file reader 405; speed adjusting buffers 406A-406C; a buffer controller 407; a transmission controller 408; and a transmission reference time generator 409 for generating a reference time for transmission.

[0038] In this configuration, image information 41

incoming from another video server (corresponding to the video server 211 in FIG. 2) is temporarily stored in the HTTP reception buffer 401. The HTTP receiver 402 sequentially reads the image information 41 from the HTTP reception buffer 401, and stores the image information 41 in the aforementioned minimum units, which allow correct decoding of the video contents, in the speed adjusting buffers 406A, 406B, 406C. While the video delivery unit of this example is provided with three speed adjusting buffers, the same operation principles can be applied if two or more buffers are provided.

[0039] It is the buffer controller 407 that manages which image information from the HTTP reception buffer 401 should be stored in which speed adjusting buffer. The buffer controller 407 instructs the HTTP receiver 402 to select the buffer which is not currently used for transmission and into which the preceding image information was written least recently, and to perform a write into the selected buffer.

[0040] The transmission controller 408 reads image information of a video content from one of the speed adjusting buffers 406A, 406B, 406C and transmits it to the client terminal as image information 43. In this event, it is again the buffer controller 407 that determines from which speed adjusting buffer the image information is read.

[0041] The transmission controller 408 receives the reference time 42 from the transmission reference time generator 409, and selects one of the speed adjusting buffers into which image information is not being written, and which

stores image information which has not been transmitted yet and should be transmitted at a time the closest to the reference time 42. At this timing, in a case where a speed adjusting buffer stores image information less recent than the transmitted image information, the transmission controller 408 discards the contents of the speed adjusting buffer, making the speed adjusting buffer writable. Also, in a case where the transmission of the image information is finished, the contents of the speed adjusting buffer is discarded to make the speed adjusting buffer writable.

[0042] The image information received by the HTTP receiver 402 is sent not only to the speed adjusting buffers but also to the file writer 403 for storage in the video storage 404. Also, when an audience request is sent for image information which has been stored in the video storage 404, the file reader 405, instead of the HTTP receiver 402, reads the requested image information from the video storage 404 and stores it in the speed adjusting buffers 406A, 406B, 406C.

[0043] FIG. 6 is a diagram illustrating an exemplary format for the image information in this embodiment. Since image information is often compression encoded using differential information, it is not always the case that a video content can be restored whichever location the information is decoded from. More frequently, the reproduction of a video content can be started only from a particular point. A video content can be regarded as a sequence of a plurality of still images.

[0044] A plurality of information pieces for still images

forming part of a video content are designated 501A, 502A, 502B, 502C, 501B. When the video content is encoded, differential information between one image and the following image is used for encoding a majority of still images 502A, 502B, 502C within this sequence of still images, so that it is difficult to retrieve and decode only such still images.

[0045] On the other hand, some of the still images such as 501A, 501B are encoded independently of previous and following still images such that the video content can be started from these images. These still images are referred to as "I frames." If the video content is decoded from the beginning of a header added to the beginning of codes in an I frame, the video content can be correctly decoded. For this reason, this point is referred to as a "random access point."

[0046] The video content is further divided into smaller fragments (packets) 503A, 503B, 503C, 503D, 503E, . . . , 503F, 503G, 503H when it is transmitted. Within these packets, the head packet 503A (503G as well) of the packets comprising an I frame image stores a time stamp 505 which describes a relative time at which the information is reproduced in a packet header 504. Packets included between the head packets of two consecutive I frames, for example, packets 503A-503F in FIG. 6 define a minimum unit for reproducing the video content. When packets are stored in a speed adjusting buffer or the like, they are stored in minimum units N (N is a natural number).

[0047] FIG. 7 is a diagram for explaining an example of extended functions for the video delivery unit of the present

invention. In FIG. 7, an HTTP reception buffer 401, an HTTP receiver 402, a file writer 403, a video storage 404, a file reader 405, speed adjusting buffers 406A, 406B, 406C, a buffer controller 407 operate in the same manner as their respective counterparts in FIG. 5. A multicast transmitter 408 operates in the same manner as the transmission controller 408 in FIG. 5.

[0048] The embodiment of FIG. 7 includes a transmission function, added to the embodiment of FIG. 5, for transmitting image information to a plurality of client terminals in accordance with the HTTP protocol. Since the HTTP protocol is essentially intended for point-to-point communications, it is not suitable for transmitting the same information simultaneously to a plurality of terminals.

[0049] Therefore, this embodiment separately provides HTTP transmission controllers corresponding to a terminal A 603A and a terminal B 603B, respectively. An HTTP transmission controller 601A is responsible for transmission to the terminal A 603A, and has a buffer 602A for temporarily storing information to be transmitted. Similarly, an HTTP transmission controller 601B is responsible for transmission to the terminal B 603B, and has a buffer 602B for temporarily storing information to be transmitted. A similar configuration may be applied for transmitting image information to three or more terminals.

[0050] In FIG. 7, the terminal A 603A first transmits a video transmission request 64A in sequence to the HTTP

transmission controller 601A. The HTTP transmission controller 601A, upon receipt of the video transmission request 64A, reads information from the buffer 602A for transmission to the terminal A 603A as image information 63A. As the buffer 602A has a free space, the HTTP transmission controller 601A reads image information to be next transmitted from one of the speed adjusting buffers 406A, 406B, 406C, and stores the read image information in the buffer 602A. In this event, it is the buffer controller 407 that determines from which speed adjusting buffer image information is read, as is the case of FIG. 5.

[0051] The buffer controller 407 selects a speed adjusting buffer which stores the most recent image information that has not been transmitted to the terminal A 603A, and into which image information is not being written. The buffer controller 407 selects a like speed adjusting buffer for the terminal B 603B. Unlike the configuration shown in FIG. 5, however, the contents of the buffer is not discarded even when the image information to respective terminals has been transmitted, since transmission of the image information to other terminal(s) may not be finished yet.

[0052] FIG. 8 is a diagram for explaining an exemplary video transmission method between a video server and a terminal according to the HTTP protocol. In this example, one or more HTTP communications are simultaneously performed for improving the utilization efficiency of transmission paths. Generally, the HTTP protocol involves a procedure in which the transmission side responds to a transmission request from the reception side,

so that a transmission path is left unused until a response is returned from the transmission side after the transmission request has been sent from the reception side, thereby causing a lower efficiency. To solve this problem, this embodiment enables a plurality of transmission requests to be issued to a server even for a period from the time the first request has been issued to the time a response is returned.

[0053] A video content from an image information source 701 is stored in the speed adjusting buffers 702A, 702B, 702C, in a manner similar to the embodiment of FIG. 5. The video content stored in the speed adjusting buffers 702A, 702B, 702C is overwritten and erased from the oldest one irrespective of whether it has been transmitted or not. A selector 703 selects, in response to a request from a transmitter associated with each terminal, selects a speed adjusting buffer which stores the most recent video content and into which a write is not being executed, from among the speed adjusting buffers 702A, 702B, 702C, and sends the contents of the selected speed adjusting buffer to the transmitter.

[0054] A transmitter is provided in correspondence to each reception side for responding to requests from a plurality of transmission sides. For example, a transmitter 704A is provided for a receiver 708A of a terminal A, and a transmitter 704B is provided for a receiver 708B of a terminal B. The transmitter 704A for the terminal A and the receiver 708A of the terminal A are connected over a transmission path 707 through a plurality of independent logical transmission paths in accordance with

the HTTP protocol. In this example, three HTTP protocol connections are used. The transmitter 704B for the terminal B and the receiver 708B of the terminal B are also connected in a similar manner.

[0055] An HTTP reception controller 709A provided in the receiver 708A of the terminal A transmits a transmission request 71 to the transmitter 705A for the terminal A. As a response to the request, a video content 72 is transmitted from an HTTP transmitter 705A to the HTTP reception controller 709A. Similarly, an HTTP reception controller 709B receives a video content from an HTTP transmission controller 705B, and an HTTP reception controller 709C receives a video content from an HTTP transmission controller 705C.

[0056] Each of the HTTP reception controllers 709A, 709B, 709C in the terminal A transmits the next transmission request 71 to the HTTP transmission controller 705A, 705B, 705C associated therewith immediately after it has received the video content. The HTTP transmission controllers 705A, 705B, 705C, upon receipt of the transmission request 71 from the HTTP reception controllers 709A, 709B, 709C associated therewith, each refers to the contents of a transmitted time stamp memory 706 to compare a time stamp of image information of the most recent video fragment transmitted to the terminal A with time stamps of image information stored in the speed adjusting buffers 702A, 702B, 702C. Only when the speed adjusting buffers 702A, 702B or 702C store image information having more recent time stamps than the time stamp of the transmitted video content,

a selector 703 selects the most recent video fragment stored in the speed adjusting buffer 702A, 702B or 702C for transmission.

[0057] The time stamp of the transmitted image information is stored in the transmitted time stamp memory 706. When the speed adjusting buffers 702A, 702B, 702C do not store image information having a time stamp more recent than the stored time stamp, the transmission is delayed until recent image information is written into the speed adjusting buffers 702A, 702B, 702C.

[0058] The respective HTTP reception controllers 709A, 709B, 709C transmit, independently of one another, transmission requests 71 to the HTTP transmission controllers 705A, 705B, 705C associated therewith. Each time the HTTP transmission controllers 705A, 705B, 705C receive the transmission request 71, they merely transmit back the most recent image information at that time as image information 72. Therefore, the image information transmitted back to the HTTP reception controllers 709A, 709B, 709C does not always reach in order. Further, the HTTP reception controllers 709A, 709B, 709C may fail to receive image information due to communication failures or the like.

[0059] For the reason set forth above, the image information received at the HTTP reception controllers 709A, 709B, 709C must be sent to a decoder 712A after it is rearranged in correct order. A selector 711 compares a time stamp stored in a decoded time stamp memory 710 with time stamps of the image information which has reached the HTTP reception controllers

709A, 709B, 709C to select the HTTP reception controller which stores the least recent image information except for already decoded image information, and sends the image information stored therein to the decoder 712A.

[0060] After the image information is sent to the decoder 712A, the associated HTTP reception controller again sends a transmission request 71 to the HTTP transmission controller. A time stamp of the image information sent to the decoder 712A is stored in the decoded time stamp memory 710. If image information previous to the decoded time stamp reaches any of the HTTP reception controllers 709A, 709B, 709C, the HTTP reception controller stops receiving the image information at that time, discards the image information which has been received, and immediately sends the next transmission request 71.

[0061] The operations in the transmitter 704B for the terminal B, the receiver 708B for the terminal B, and a decoder 712B are similar to the foregoing.

[0062] According to the present embodiment, it is made possible to provide a service to simultaneously distribute a video content to a plurality of locations via a wide area network wherein a firewall is set up, using a multicast technology. To enjoy this service, the receiving client needs no special mechanism, but merely a common multicast receiving function is required.

[0063] Further, even where there is an inconsistency in transmission speed due to the switching between protocols in

a transmission path, since the embodiment is so adapted that the coding/decoding of the image information does not suffer from a trouble, the deterioration in a quality of the displayed image is minimized. Since a video transmission through a transmission path including a firewall equals a video transmission to a client through the transmission path, it is unlikely that the transmission path suffers from a heavy load.

[0064]

[Effects of the Invention] The present invention can provide a video server capable of transmitting a same video content to a plurality of clients by using multicast, even where a firewall is set between the video server and the plurality of clients, reducing the transmission cost.

[Brief Description of Drawings]

[FIG. 1] FIG. 1 is a block diagram illustrating an example of a video distribution system in which two video servers according to the present invention are connected through a transmission path which does not allow IP multicast to pass therethrough.

[FIG. 2] FIG. 2 is a flow diagram for explaining the operational flow of the video distribution system utilizing the video servers described in FIG. 1.

[FIG. 3] FIG. 3 is a flow chart for explaining the operation of the video server system illustrated in FIG. 2.

[FIG. 4] FIG. 4 is a diagram illustrating an example of management information stored in video management tables 204, 214.

[FIG. 5] FIG. 5 is a block diagram illustrating an exemplary configuration of a video delivery unit.

[FIG. 6] FIG. 6 is a diagram illustrating an exemplary format for image information in the embodiment of the invention.

[FIG. 7] FIG. 7 is a diagram for explaining an example of extended functions for the video delivery unit.

[FIG. 8] FIG. 8 is a diagram for explaining an exemplary video transmission method according to the HTTP protocol.

[Description of Reference Numerals]

11 wide area network allowing only HTTP-based information to pass (HTTP network)

12A, 12B local area network capable of multicast (IP network)

101A,101B video server

102A, 102B video storage

103A, 103B client terminal

104 firewall

21 multicast video audience request

22 reception parameters

23 transmission command

24 video content

25 audience request

26 reception parameters

27 transmission command

28 video content

201, 211 video server

202 client terminal

203, 213 video management unit

204, 214 video management table

205, 215 video delivery unit

206, 216 video storage

41 received image information

42 reference time information

43 transmitted image information

401 HTTP reception buffer

402 HTTP receiver

403 file writer

404 video storage

405 file reader

406A, 406B, 406C speed adjusting buffers

407 buffer controller

408 transmission controller

409 transmission reference time generator

501A, 501B still image information of I frame

502A, 502B, 502C still image information

503A, 503B, 503C, 503D, 503E, 503F, 503G, 503H packets

504 packet header

505 time stamp

63A image information to terminal A in accordance with HTTP protocol

63B image information to terminal B in accordance with HTTP protocol

64A video transmission request from terminal A in accordance with HTTP protocol

64B video transmission request from terminal B in accordance with HTTP protocol

601A HTTP transmission controller for terminal A

601B HTTP transmission controller for terminal B

602A HTTP transmission buffer for terminal A

602B HTTP transmission buffer for terminal B

603A terminal A

603B terminal B

71 transmission request

72 video content

701 image information source

702A, 702B, 702C video transmission buffers

703, 711 selector

704A transmitter for terminal A

704B transmitter for terminal B

705A, 705B, 705C HTTP transmitter

706 transmitted time stamp memory

707 transmission path

708A receiver of terminal A

708B receiver of terminal B

709A, 709B, 709C HTTP reception controller

710 decoded time stamp memory

712A decoder of terminal A

712B decoder of terminal B

FIG.1

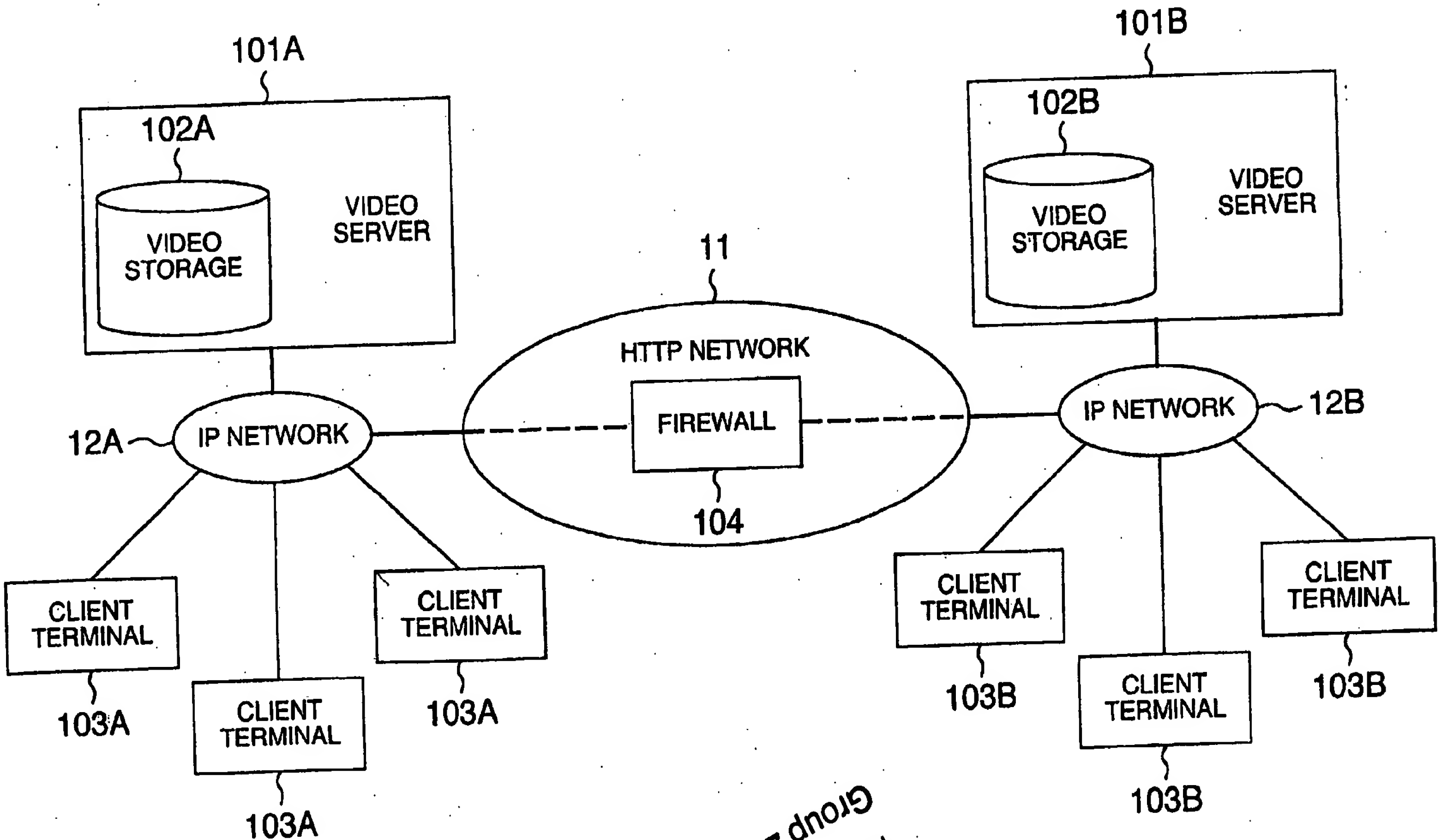

101A
102A
VIDEO STORAGE
VIDEO SERVER
12A
IP NETWORK
CLIENT TERMINAL
103A
CLIENT TERMINAL
103A
CLIENT TERMINAL
103A
11
HTTP NETWORK
FIREWALL
104
101B
102B
VIDEO STORAGE
VIDEO SERVER
IP NETWORK
12B
CLIENT TERMINAL
103B
CLIENT TERMINAL
103B
CLIENT TERMINAL
103B

FIG.2

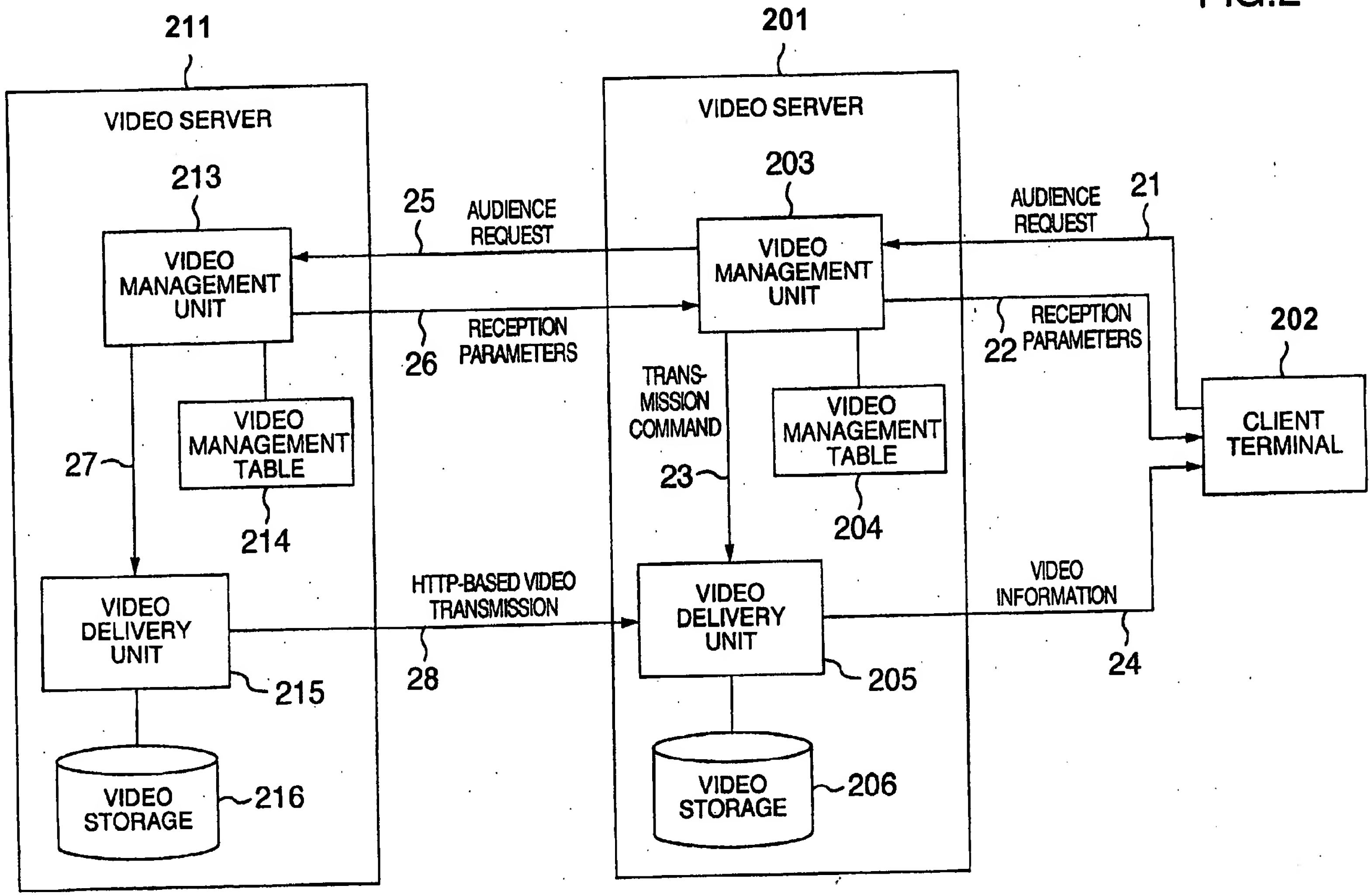

211
VIDEO SERVER
213
VIDEO MANAGEMENT UNIT
VIDEO MANAGEMENT TABLE
214
27
VIDEO DELIVERY UNIT
215
VIDEO STORAGE
216
25
AUDIENCE REQUEST
26
RECEPTION PARAMETERS
HTTP-BASED VIDEO TRANSMISSION
28
201
VIDEO SERVER
203
VIDEO MANAGEMENT UNIT
TRANS-MISSION COMMAND
23
VIDEO MANAGEMENT TABLE
204
VIDEO DELIVERY UNIT
205
VIDEO STORAGE
206
AUDIENCE REQUEST
21
RECEPTION PARAMETERS
22
VIDEO INFORMATION
24
202
CLIENT TERMINAL

FIG.3

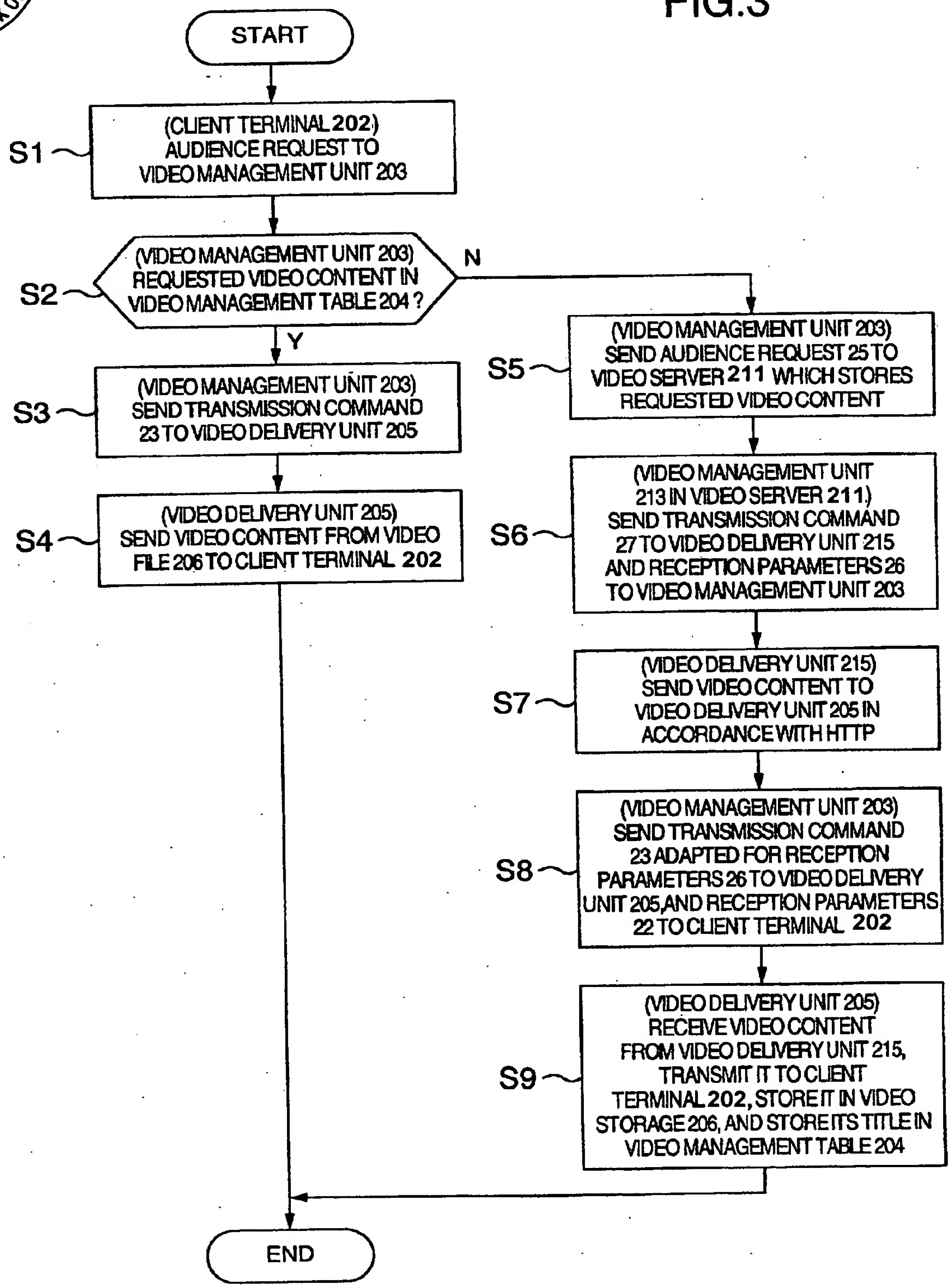

START
S1
(CLIENT TERMINAL 202) AUDIENCE REQUEST TO VIDEO MANAGEMENT UNIT 203
S2
(VIDEO MANAGEMENT UNIT 203) REQUESTED VIDEO CONTENT IN VIDEO MANAGEMENT TABLE 204 ?
N
Y
S3
(VIDEO MANAGEMENT UNIT 203) SEND TRANSMISSION COMMAND 23 TO VIDEO DELIVERY UNIT 205
S4
(VIDEO DELIVERY UNIT 205) SEND VIDEO CONTENT FROM VIDEO FILE 206 TO CLIENT TERMINAL 202
S5
(VIDEO MANAGEMENT UNIT 203) SEND AUDIENCE REQUEST 25 TO VIDEO SERVER 211 WHICH STORES REQUESTED VIDEO CONTENT
S6
(VIDEO MANAGEMENT UNIT 213 IN VIDEO SERVER 211) SEND TRANSMISSION COMMAND 27 TO VIDEO DELIVERY UNIT 215 AND RECEPTION PARAMETERS 26 TO VIDEO MANAGEMENT UNIT 203
S7
(VIDEO DELIVERY UNIT 215) SEND VIDEO CONTENT TO VIDEO DELIVERY UNIT 205 IN ACCORDANCE WITH HTTP
S8
(VIDEO MANAGEMENT UNIT 203) SEND TRANSMISSION COMMAND 23 ADAPTED FOR RECEPTION PARAMETERS 26 TO VIDEO DELIVERY UNIT 205,AND RECEPTION PARAMETERS 22 TO CLIENT TERMINAL 202
S9
(VIDEO DELIVERY UNIT 205) RECEIVE VIDEO CONTENT FROM VIDEO DELIVERY UNIT 215, TRANSMIT IT TO CLIENT TERMINAL 202, STORE IT IN VIDEO STORAGE 206, AND STORE ITS TITLE IN VIDEO MANAGEMENT TABLE 204
END

FIG.4

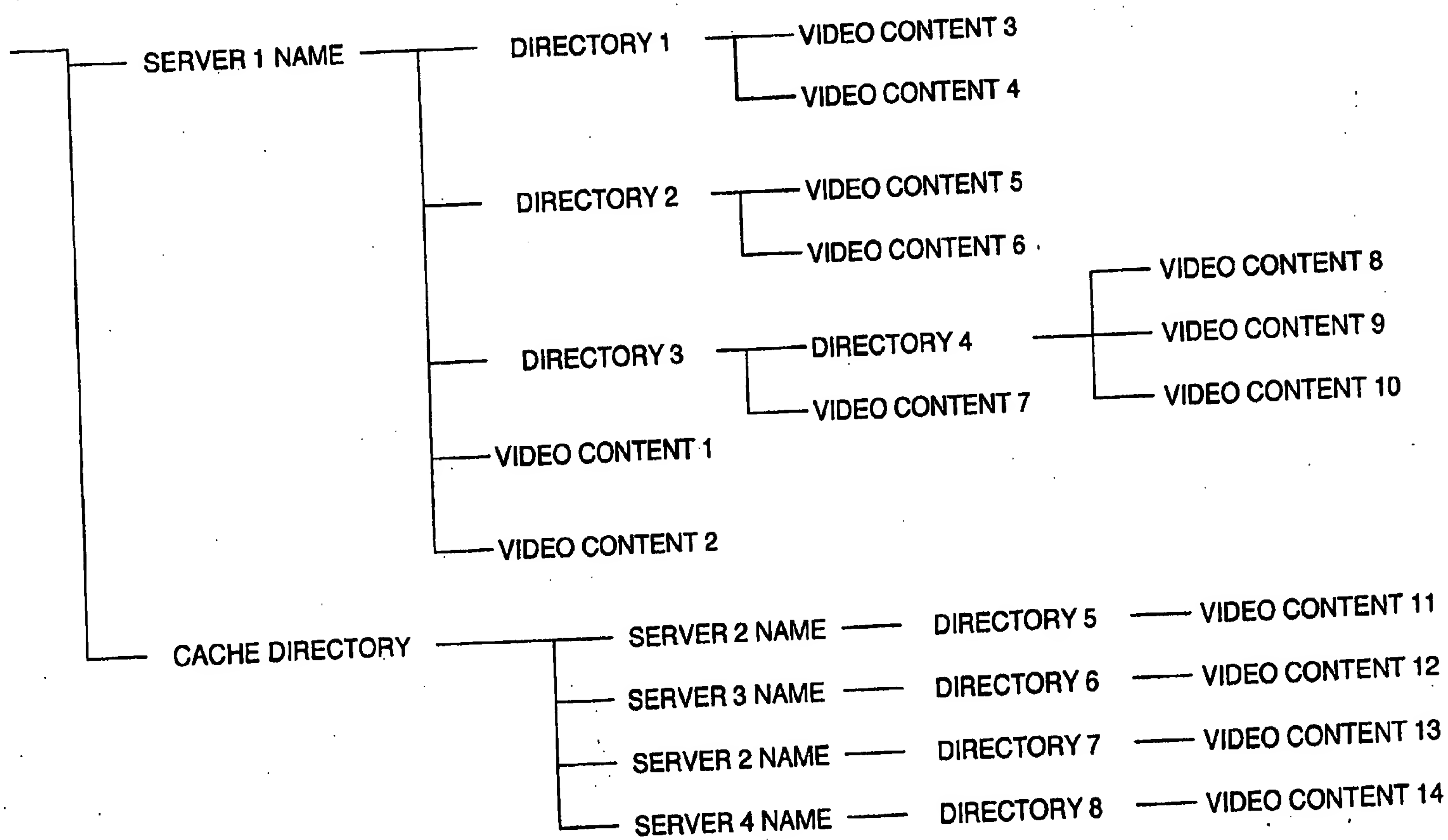

SERVER 1 NAME
DIRECTORY 1
VIDEO CONTENT 3
VIDEO CONTENT 4
DIRECTORY 2
VIDEO CONTENT 5
VIDEO CONTENT 6
DIRECTORY 3
DIRECTORY 4
VIDEO CONTENT 8
VIDEO CONTENT 9
VIDEO CONTENT 10
VIDEO CONTENT 7
VIDEO CONTENT 1
VIDEO CONTENT 2
CACHE DIRECTORY
SERVER 2 NAME
DIRECTORY 5
VIDEO CONTENT 11
SERVER 3 NAME
DIRECTORY 6
VIDEO CONTENT 12
SERVER 2 NAME
DIRECTORY 7
VIDEO CONTENT 13
SERVER 4 NAME
DIRECTORY 8
VIDEO CONTENT 14

FIG.5

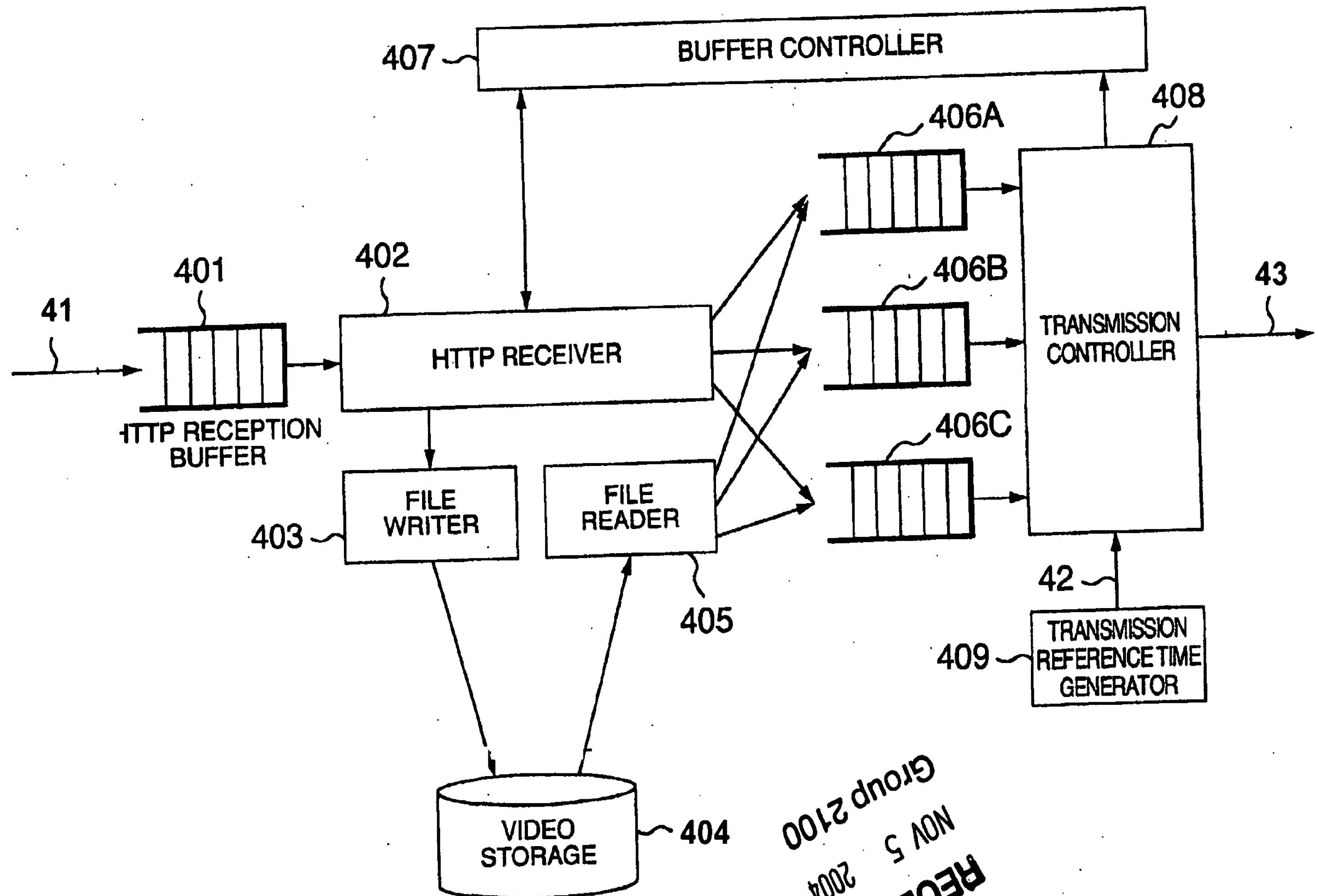

BUFFER CONTROLLER
407
408
406A
406B
406C
401
402
41
43
HTTP RECEIVER
TRANSMISSION CONTROLLER
HTTP RECEPTION BUFFER
FILE WRITER
FILE READER
403
405
42
409
TRANSMISSION REFERENCE TIME GENERATOR
VIDEO STORAGE
404

FIG.6

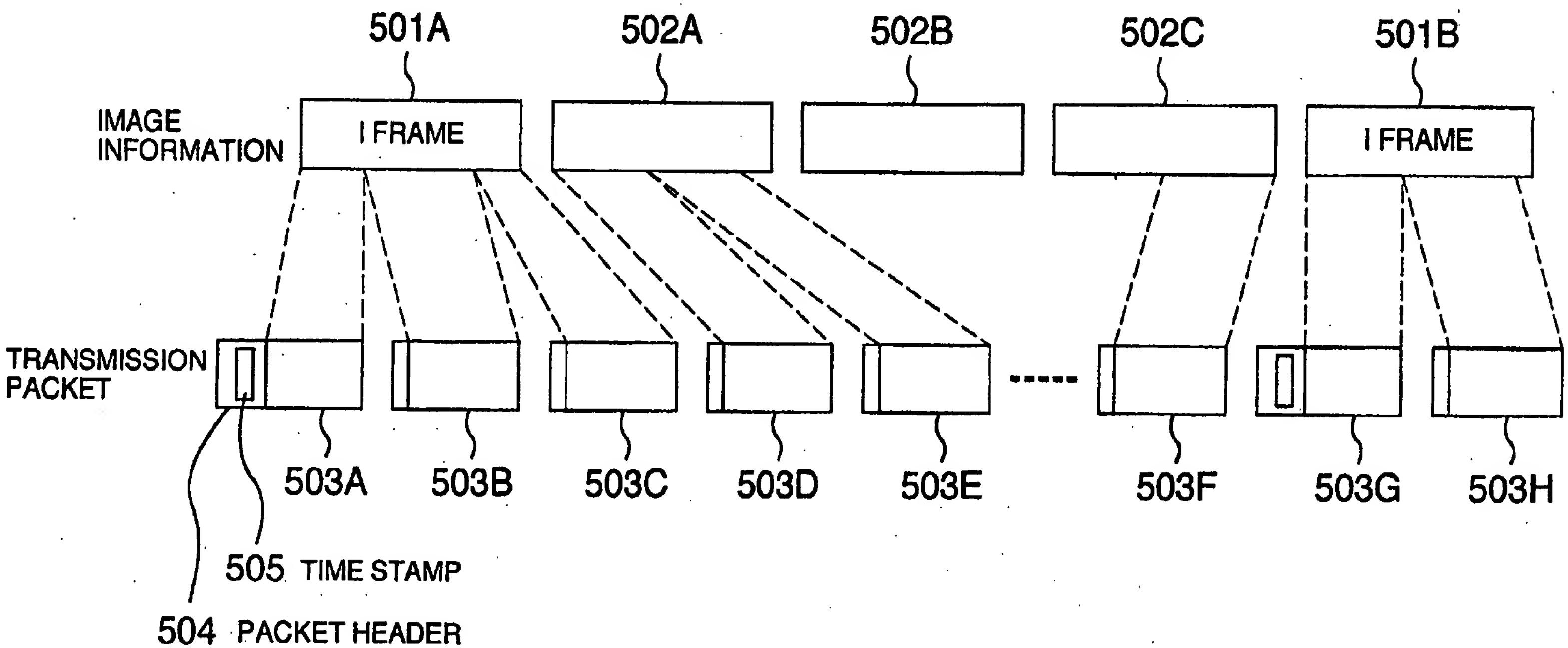

501A
502A
502B
502C
501B
IMAGE INFORMATION
I FRAME
I FRAME
TRANSMISSION PACKET
503A
503B
503C
503D
503E
503F
503G
503H
505 TIME STAMP
504 PACKET HEADER

FIG.7

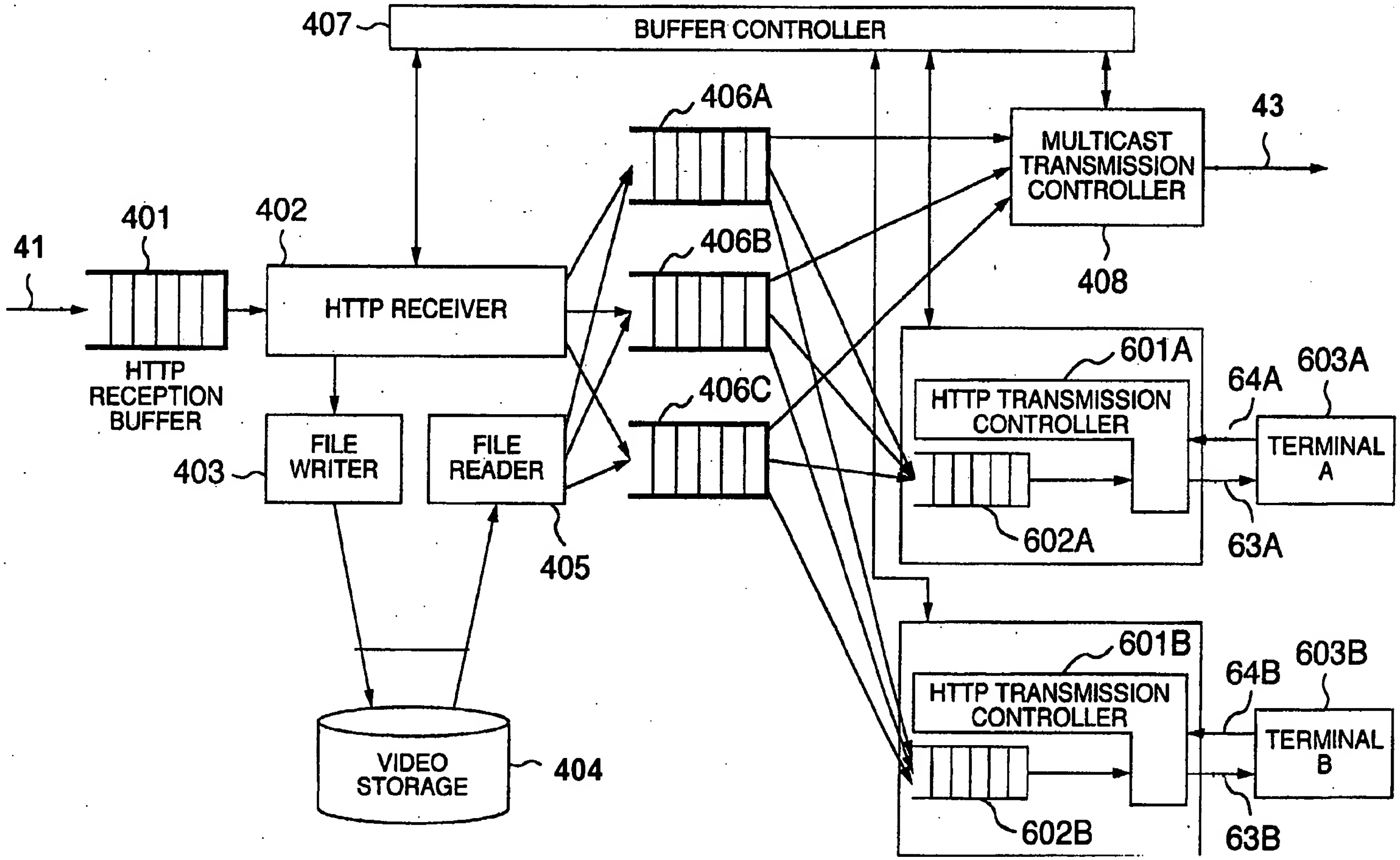
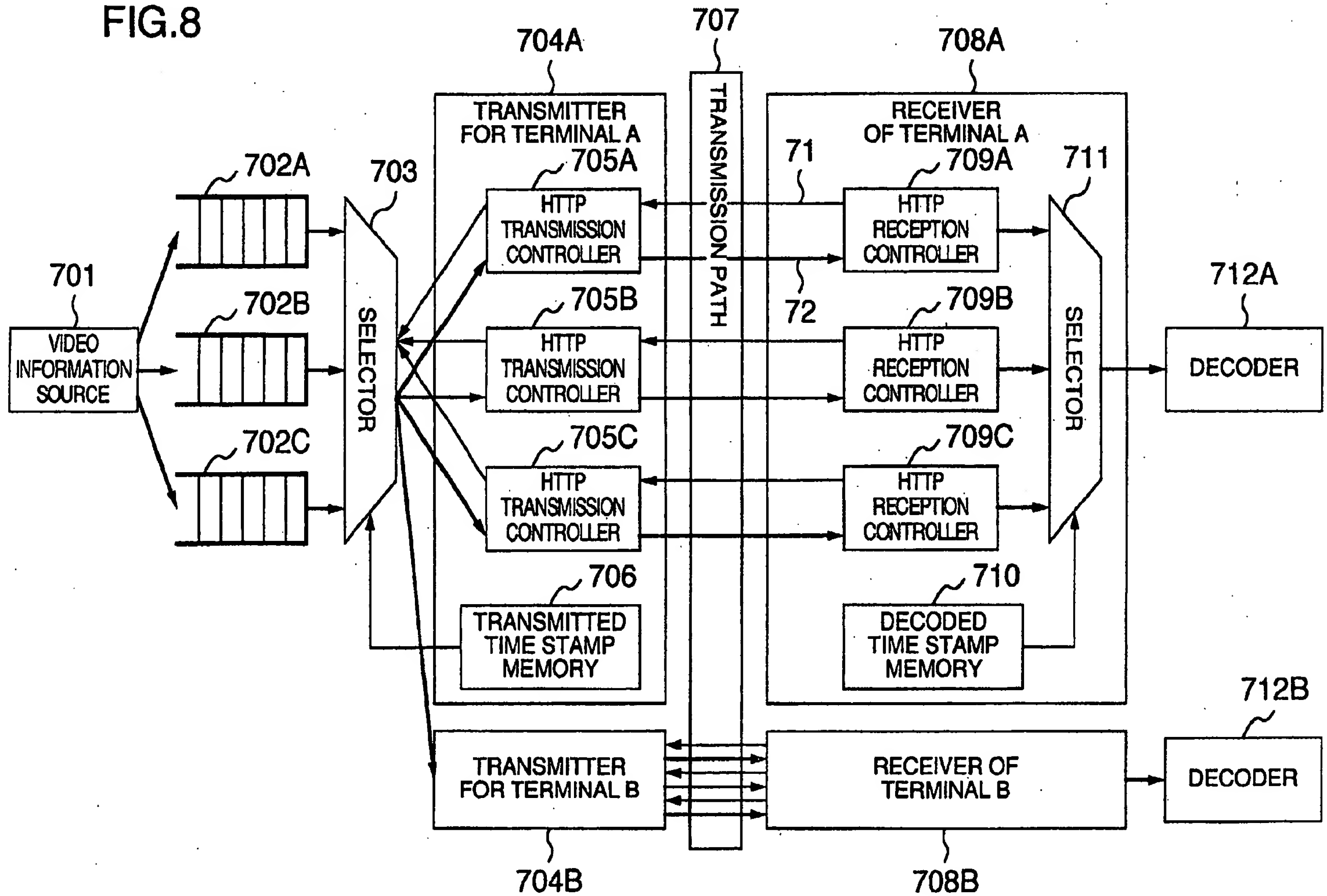

407
BUFFER CONTROLLER
41
401
HTTP RECEPTION BUFFER
402
HTTP RECEIVER
403
FILE WRITER
FILE READER
405
VIDEO STORAGE
404
406A
406B
406C
MULTICAST TRANSMISSION CONTROLLER
408
43
601A
HTTP TRANSMISSION CONTROLLER
602A
64A
603A
TERMINAL A
63A
601B
HTTP TRANSMISSION CONTROLLER
602B
64B
603B
TERMINAL B
63B

FIG.8


701
VIDEO INFORMATION SOURCE
702A
702B
702C
703
SELECTOR
704A
TRANSMITTER FOR TERMINAL A
705A
HTTP TRANSMISSION CONTROLLER
705B
HTTP TRANSMISSION CONTROLLER
705C
HTTP TRANSMISSION CONTROLLER
706
TRANSMITTED TIME STAMP MEMORY
707
TRANSMISSION PATH
708A
RECEIVER OF TERMINAL A
71
72
709A
HTTP RECEPTION CONTROLLER
709B
HTTP RECEPTION CONTROLLER
709C
HTTP RECEPTION CONTROLLER
710
DECODED TIME STAMP MEMORY
711
SELECTOR
712A
DECODER
704B
TRANSMITTER FOR TERMINAL B
708B
RECEIVER OF TERMINAL B
712B
DECODER